SUPPLEMENTAL ECOLOGICAL EVALUATION REPORT

FORMER CHEVRON FACILITY
PERTH AMBOY, NEW JERSEY
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Acronym Glossary

AOCs	Areas of Concern
BEE	Baseline Ecological Evaluation
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
CMS	Corrective Measurement Study
COPECs	Contaminants of Potential Environmental Concern
DAP	Diffuse Anthropogenic Pollutants
DOCC	Chevron's August 1994 *Description of Current Site Conditions*
EE	Ecological Evaluation
EETG	NJDEP Ecological Evaluation Technical Guidance
EPA	United States Environmental Protection Agency
EPH	Extractable Petroleum Hydrocarbon
ER-L	NJDEP Effects Range-Low (ESC for saline water sediment)
ER-M	NJDEP Effects Range-Medium (ESC for saline water sediment)
ESC	Ecological Screening Criteria NJDEP 2009
ESNR	Ecologically Sensitive Natural Resources
ft amsl	Feet Above Mean Sea Level
HWSA	Hazardous and Solid Waste Amendments
LNAPL	Light, non-aqueous phase liquid
LSSLs	NJDEP Lower Ecological Soil Screening Level
NFE	North Field Extension
NJDEP	New Jersey Department of Environmental Protection
NJPDES	New Jersey Pollutant Discharge Elimination System
PAHs	Polycyclic Aromatic Hydrocarbons
PID	Photoionization Detector
PCBs	Polychlorinated Biphenyls
ppt	Parts Per Thousand
RCRA	Resource Conservation and Recovery Act
RIR	Chevron's 2005 Remedial Investigation Report
RFI Report	Chevron's November 2003 *RCRA Facility Investigation Report*
SPM	Separate Phase Material as defined in the TRSR
SRFI Report	Chevron's 2008 *Supplemental RFI Report*
SWQC	NJDEP Surface Water Quality Criterion
SWMUs	Solid Waste Management Units
SVOCs	Semi volatile Organic Compounds
TAN	Total Ammonia Nitrogen
TAL/TCL +30	Target Analyte List/Target Compound List
TOC	Total Organic Carbon
TPHC	Total Petroleum Hydrocarbons
TRSR	NJDEP Technical Requirements for Site Remediation
USSLs	NJDEP Upper Ecological Soil Screening Level
VOCs	Volatile Organic Compounds

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Former Chevron Facility – Perth Amboy, New Jersey

1.0 INTRODUCTION

TRC Environmental Corporation (TRC), on behalf of Chevron Environmental Management Company (Chevron), has prepared this Supplemental Ecological Evaluation Report (Supplemental EE) for the Former Chevron Facility (Facility) located in Perth Amboy, New Jersey (Figure 1). This report supplements the Baseline Ecological Evaluation (BEE) that was included in Chevron's November 2003 Resource Conservation and Recovery Act (RCRA) Facility Investigation Report (RFI Report) and the related information provided by Chevron in the February 2008 Supplemental RFI Report (SRFI Report). It also includes responses to the NJDEP's 2004 and 2009 RFI and SRFI report comment letters (Appendix A), in accordance with Chevron's October 11, 2010 response letter to the New Jersey DEP's October 2009 SRFI Report comments.

The Supplemental EE is being submitted pursuant to the Hazardous and Solid Waste Amendments (HSWA) Renewal Permit for the Facility issued by the United States Environmental Protection Agency (EPA) in 2013. While EPA is the lead regulatory agency for the oversight of RCRA corrective action at the Facility, NJDEP has provided technical review of the ecological evaluations for EPA. The Supplemental EE was prepared in accordance with the NJDEP's Technical Requirements for Site Remediation (TRSR) and Ecological Evaluation Technical Guidance (EETG). The scope for the November 2003 RFI was completed under the former BEE requirements. However, the BEE requirements have since been superseded by the most current TRSR, which now require an EE. It should be noted that the previous BEE work, and recent EE investigation included in this report, include sampling and analysis, which is beyond the scope of both the NJDEP's former BEE and current EE requirements.

1.1 Background

The original BEE included a focused evaluation of surface water and sediments in the tidally flowed water bodies adjacent to the facility. These included the Arthur Kill, Spa Spring and Woodbridge Creek. Most of the watershed in this area has been densely developed for industrial and commercial use over the past century. There is a concentration of industrial uses adjacent to the Arthur Kill, including port facilities and petroleum and chemical industries. In fact, the highly industrialized Arthur Kill waterway is periodically dredged to maintain commercial navigation and much of the shoreline is comprised of man-made structures (i.e., bulk head or rip rap). In the past, Woodbridge Creek was also dredged for industrial and commercial purposes. As indicated in the RFI Report, sediments in the local water bodies, including the Arthur Kill and Woodbridge Creek contain contaminants including diffuse anthropogenic pollutants (DAP) from historical point source and non-point discharges, which make identification of contaminant sources and/or defining impacts difficult.

This Supplemental EE includes re-evaluation of Contaminants of Potential Environmental Concern, a summary of recent sediment samples collected in Spa Spring Creek and Woodbridge Creek, and a report of sediment bathymetry completed at the confluence of Woodbridge Creek and the Arthur Kill.

1.2 Summary of Prior Investigation Report Findings and EPA/NJDEP Comments

The November 2003 RFI Report BEE concluded the following:

- Spa Spring Creek, Woodbridge Creek and the Arthur Kill are environmentally sensitive natural resources present adjacent to the site, and environmentally sensitive areas are not present on site.
- COPECs including Volatile Oraganic Compounds, Semi-volatile Organic Compounds and metals are present at the site in soil and ground water at concentrations elevated above the RFI Delineation Criteria.
- Moderately high concentrations of SVOCs and metals were detected above SSGs in sediment samples collected from all three water bodies adjacent to the site.
- Nickel, mercury and zinc were detected above the Surface Water Quality Criterion in relatively few surface water sample locations at low concentrations.
- Pathways for contaminant migration from SWMUs and AOCs to environmentally sensitive natural resources do not appear to be complete.
- All contaminated soil and ground water areas adjacent to the property boundaries along Woodbridge Creek, Spa Spring Creek and the Arthur Kill have been delineated and do not extend to the environmentally sensitive areas.
- There is no indication of ongoing discharges of hazardous substances from the site based on the soil and groundwater sample analysis, and light non-aqueous phase liquid (LNAPL) investigation.
- Many area-wide, off-site, background sources are likely contributors to the presence of elevated concentrations of VOCs, SVOCs and metals in sediments, and to the slightly elevated metal concentrations in surface water.
- Staining and/or petroleum odors were also observed in several potential background locations in Woodbridge Creek sediment samples obtained from sampling transects SED-09 and SED-10 (see Vibracore Logs in Appendix D).
- Based on the BEE, further ecological evaluation of SVOCs and metal COPECs in the Woodbridge Creek sediments is recommended.

The NJDEP's BEE comments from their December 23, 2004 letter are summarized as follows:

- Identify/clarify background sample locations for COPEC evaluation
- Re-evaluate COPECs to be retained in the EE (e.g., copper in sediments)
- Further evaluation of sediment cores where staining and petroleum odors were observed, including sediment sample total petroleum hydrocarbons (TPHC) analysis
- Provide any additional migration pathway information if available

The February 2008 SRFI Report included responses to the NJDEP's 2004 Letter, provided additional data evaluation (clarification of background samples and background data re-evaluation), additional explanations and information, and noted the following items would be included in the Supplemental EE report:

- Re-evaluation of COPECs
- Further investigation of staining and petroleum odors using the latest version of NJDEP's TPHC method
- Review of historical information and 2005 Remedial Investigation Report (RIR), not included, see below;
- Identification of data gaps including TPHC investigation, re-evaluation of COPECs, and need for data from intertidal areas

The NJDEP's October 2009 letter:

- Approved Chevron's proposal to conduct further ecological evaluations as a separate task
- Acknowledged Chevron's data frequency analysis regarding COPECs as acceptable
- Reiterated concerns regarding details of the COPEC re-evaluation, including potential historical site conditions and potential for data gaps (e.g., copper analysis in ground water)
- Required further evaluation of sediments in Spa Spring Creek

As noted in Chevron's October 11, 2010 response to NJDEP's October 2009 comments, additional data collected as part of the Corrective Measures Study (CMS) were evaluated as part of this Supplemental EE, including ground water data collected through March 17, 2014 and soil data collected through April 14, 2014. In addition, the Supplemental EE includes a re-evaluation of COPECs using the current NJDEP Ecological Screening Criteria (ESCs), evaluation of TPHC, review of historical information and the 2005 RIR, and further review of Spa Spring Creek.

It should be noted that the NJDEP replaced the former TPHC methods and screening criteria with the current extractable petroleum hydrocarbons (EPH) guidance. The current EPH guidance was used for the evaluation of staining and petroleum odors associated with the Supplemental EE Report.

<u>North Field Extension (NFE)</u>
As discussed in the approved 2013 EPA Final HSWA Permit Renewal and Permit Modifications I (the RCRA Permit), Final Statement of Basis Section IV, the Northern Parcels, a 15.5-acre portion of the NFE that contains the only 5 SWMUs and 2 AOCs that were identified in the NFE, was acquired by a separate limited liability company. The liability company and its members are responsible for the site investigation and necessary corrective measures under a separate RCRA Administrative Order of Consent. The NFE, is separated from the main facility by Woodbridge Creek, and is not included in the RCRA Permit and is, therefore, not addressed in this Supplemental EE Report.

2.0 SITE INFORMATION SUMMARY

The following is a summary of site information provided in the RFI and SRFI reports; refer to those reports for more detail.

2.1 History of Ownership and Operation

The former Chevron Facility was situated on a 368-acre site in Perth Amboy and Woodbridge, Middlesex County, New Jersey (Figure 1). The former Facility received heavy crude oil from tankers and refined it into finished asphalt cement, and intermediate products.

In 1994, at the time of the issuance of the initial HSWA Permit, the Chevron permitted facility consisted of approximately 368 acres. The active facility was divided into a series of yards known as the Central Yard, East Yard, North Field/Main Yard (Main Yard), West Yard, and Amboy Field. Over the past 10 years, portions of the facility, the West Yard, and Amboy Field have been decommissioned and sold to others for the construction of commercial warehousing as part of the City of Perth Amboy's redevelopment efforts. In 2012, Chevron sold most of the remaining three yards, to Buckeye Perth Amboy Terminal, LLC. Chevron retains ownership of a small portion of the northern part of the Main Yard.

2.2 Site Location

The current Facility is situated on a 268-acre site in Perth Amboy and Woodbridge, Middlesex County, New Jersey (Figure 1). The site is bounded to the west by commercial and residential properties along Amboy Avenue. The site is bounded to the east by the Arthur Kill, which provides the Facility with docking berths for tanker ships. Woodbridge Creek flows from the northwest to southeast through the northern portion of the Facility. Spa Spring Creek flows along the northern property boundary and discharges into Woodbridge Creek (Figure 2).

Amboy Avenue runs north-south along the western boundary of the Facility and State Street runs north-south through the eastern portion of the Facility. Maurer Road crosses east-west through the central portion of the Facility and connects Amboy Avenue to State Street.

2.3 Industrial Land Use Adjacent to the Facility

The following industrial properties have historically, or currently border the former Facility area:

- Witco Chemical
- Bird and Sons Landfill
- Joline Properties
- American Smelting and Refining Company (ASARCO)
- Amerada Hess
- American Cyanamid
- Jadler Metals
- Texeira's Bakery
- Englert

- Russel Stanley Corporation
- CP Chemical Inc.
- Shell Oil Company
- Empire Polymer Corporation
- V&S Amboy Galvanizing

In addition, there are small businesses along State Street that border Chevron's Central Yard, including R&L Towing, T&I Transmissions, Sylvan Industrial Piping and Abe Golub Used Cars. Descriptions of these properties, including available information regarding potential environmental issues related to their operation, were documented in Chevron's report entitled *Description of Current Site Conditions* (DOCC) (ESE, August 1994).

2.4 Physiographic Setting

The Facility is located near the western boundary of the Atlantic Coastal Plain Physiographic Province of Central New Jersey. The Coastal Plain is characterized as relatively flat northeast-trending lowland with topographic elevations that rise gently from sea level at the coastline. The ground surface elevation at the northern, central, and eastern portions of the former Facility site varies from 0 to 84 feet above mean sea level (ft amsl). The surface topography has been shaped by pre-historic glaciation, stream erosion, and cut and fill grading activity conducted prior to and during site development. The site is bounded to the east by Arthur Kill, which provides the former Facility with docking berths for tanker ships. Woodbridge Creek flows from the northwest to southeast through the northern portion of the former Facility and has been classified by the State of New Jersey as an FW2-NT/SE3 surface water body, although salinity data collected from the creek indicates that the creek water is brackish [salinity is greater than 17 parts per thousand (ppt)]. Spa Spring Creek flows along the northern property boundary and discharges into Woodbridge Creek. Ground water at the facility is saline in some areas due to naturally occurring salt water intrusion. Prior to site development, the land areas adjacent to Woodbridge Creek and Arthur Kill were tidal marshlands with small, meandering tidal creeks, streams, and shallow swales that provided surface drainage. The tidal marshlands were filled and sheet piling was installed along portions of the site adjacent to Arthur Kill, Woodbridge Creek, and Spa Spring Creek to stabilize the fill zones and prevent sloughing into the adjacent creeks.

2.5 Site Geology

The general stratigraphy of the Facility consists of six major units which overlie the bedrock, including fill, organic clay and peat, glacial till and outwash, and Raritan Formation sand and clay. The surface and shallow soils are composed of fill over large portions of the site, which is generally less than ten feet thick, but can be up to 20 feet thick. In some areas, the fill appears to be derived from on-site glacial deposits, and consists largely of sand, with variable amounts of silt, clay and gravel. Non-indigenous material in some areas of the fill includes miscellaneous debris, ash, and construction/demolition type debris. Clay soils beneath the site include the Raritan Fire Clay ranging in thickness from 12 to 20 feet and the Woodbridge Clay, which is less than 50 feet thick. The Farrington Sand is 15 to 25 feet thick and is continuous beneath the site, except at the eastern section adjacent to the Arthur Kill, where it was apparently removed by erosion.

Bedrock was encountered in several deep borings on-site at 65 to 85 feet bgs. There is a layer of saprolite that overlies competent bedrock, which formed from very well-weathered and decomposed rock (either diabase or mudstone of the Lockatong Formation). The saprolite grades upward into the Raritan Fire Clay without a distinct contact. The saprolite appears to be laterally continuous across the site and is typically up to five feet thick.

2.6 Site Hydrogeology

The upper water bearing unit at the Facility is an unconfined shallow water bearing zone that is present within the fill layer. A middle water bearing zone is present within the glacial outwash deposits. The lower water bearing unit is the Farrington Sand, which has been used in the past in the Perth Amboy area as a local public water supply source, or drinking water source unit, but is no longer used for these purposes.

In the northern and eastern areas of the Facility, the upper water bearing zone in the fill is separated from the water bearing zones in the glacial outwash and Farrington Sand (where present) by the organic clay unit. In the southern and western areas of the Facility, the organic clay unit pinches out and the water bearing zone in the fill is underlain by the glacial till, or glaciolacustrine clays. The Farrington Sand is further isolated from groundwater within the fill by the Woodbridge Clay. The low permeability clays and silts that separate the permeable water bearing zones are discontinuous.

In general, groundwater is encountered at depths ranging from two feet bgs in the low lying areas of the Facility, to an approximate maximum depth of 10 feet bgs in the areas of higher elevation. Site data indicate that hydraulic communication between the permeable zones is limited where the intervening low permeability units are present. Groundwater flow direction also varies between the zones. Based on limited historical data, the groundwater in the Farrington Sand beneath the Facility generally flows to the east or southeast, which is similar to the regional flow pattern.

Potentiometric data from well pairs, consisting of one well screened across the water table and one well screened below the water table, indicate that there is an upward hydraulic gradient from the native clays and glacial units below the fill towards the water bearing unit in the fill. This upward gradient probably limits the downward migration of dissolved contaminants in the groundwater.

Tidally influenced groundwater level fluctuations and saltwater intrusion into the shallow water bearing zone have been observed and documented in the areas near Woodbridge Creek. Saltwater intrusion into the Farrington Sand has been documented in the area south of Woodbridge Creek at and near the Facility.

2.7 Adjacent Surface Water Bodies

Three surface water bodies border portions of the Facility along its northern boundary (Spa Spring Creek and Woodbridge Creek) and eastern boundary (Arthur Kill) (see Figure 2). In the vicinity of the Facility, Woodbridge Creek and Spa Spring Creek are tidal estuarine waters, with Woodbridge Creek having several prominent meanders along its course. Thus, water flow and elevation in the creeks are controlled by the diurnal tide cycle. Woodbridge Creek is bounded by mudflats and tidally-flowed wetlands, as well as numerous industrial properties. At high tide, the Creek is approximately 100 feet wide as it flows past the Facility. Woodbridge Creek empties into the Arthur Kill several hundred feet north of the Facility's East Yard. Spa Spring Creek is a smaller, manmade channel that empties into Woodbridge Creek at the NFE area of the Facility.

The Arthur Kill itself is a tidal strait connecting the Kill van Kull and Newark Bay to the north with Raritan Bay and the Raritan River to the south. Tidal surges come from both ends, with an average flushing time of two weeks and an average semi-diurnal tidal range of 1.6 meters (5.3 feet). The major freshwater inputs are the major tributaries of the Arthur Kill: the Rahway River, the Elizabeth River, and the Fresh Kills, which contribute about 38 percent (122 cubic feet per second (ft^3/sec)), with the balance of 62 percent (200 ft^3/sec) coming from smaller tributaries, sewage treatment plants, combined sewer overflows, and industrial discharges. The salinity of the Arthur Kill varies from 17 to 27 ppt at the southern end to nearly freshwater in some of the tributary mouths. The Arthur Kill is surrounded by one of the most densely populated coastal areas in the world.

Vast modifications of the physical features of the Arthur Kill were made to serve the harbor area. The highly industrialized waterway is dredged to an average channel depth of nine meters (30 feet) and much of the shoreline is comprised of bulkheads or rip-rap. In addition to vegetated wetland areas, the vicinity contains extensive interspersed areas of man-made structures, including railroad yards, oil tank farms, bulkheads, docks, road systems, landfills, and numerous industrial and residential buildings, both occupied and abandoned.

Historically, the Facility has discharged treated wastewaters to outfalls located in Spa Spring Creek and Woodbridge Creek. The Facility's current NJPDES permitted wastewater discharge is located in Woodbridge Creek.

3.0 TECHNICAL OVERVIEW

This section provides a technical overview of the EE activities conducted since 2010 at the Perth Amboy Chevron Facility. The ecological areas (surface waters) that are the subject of this evaluation include Woodbridge Creek, Spa Spring Creek and the Arthur Kill.

3.1 Supplemental EE Objectives

The overall objectives of the Supplemental EE includes addressing the outstanding issues identified in the NJDEP's comments in their 2004 and 2009 letters in accordance with Chevrons's responses provided in the 2008 SRFI and October 2010 response letter (as summarized in Section 1.2). To meet these objectives, Chevron completed the following tasks:

1. Identified and addressed data gaps that were identified in NJDEP comment letters;
2. Performed a re-evaluation of soil, ground water, surface water and sediment COPECs, including review of the additional CMS data;
3. Conducted sampling and analysis to further evaluate background conditions and prior boring locations where evidence of product was observed (staining/petroleum odors); and reviewed available historical information for potential historical migration pathways; and
4. Completed a bathymetric survey of lower Woodbridge Creek to estimate the down-stream extent of the sediment.

3.2 Sampling Procedures

During the investigation, sediment samples were collected using a hand auger and a vibracore sampling device. The vibracore samples were collected by Aqua Survey, Inc. of Flemington, New Jersey (ASI) using a 27 foot pontoon boat with vibracore sampler attached. A vibracore barrel lined with a dedicated, clear plastic liners and fitted sediment trap were advanced into the creek sediment to achieve penetration to refusal. The vibracore barrels were then removed from the creek and the sediment filled liners removed from within the barrel and placed on the boat deck, sealed and properly labeled. During this process a TRC geologist oversaw the operation and monitored ambient air readings using a Multi-RAE 5-gas meter.

Once the sediment cores were collected they were brought to the East Yard of the Facility by accessing of the Atlantic Response floating pier. Each core was screened at 6-inch intervals for volatile organic vapors with a photoionization detector (PID), recovery was measured and lithology was recorded. Boring Logs are included as Appendix B.

3.3 Remediation Standards and Criteria

According to the TRSR and EETG, COPECs include substances that exhibit the ability to biomagnify or bioaccumulate, or that are present at concentrations that exceed NJDEP ESC and/or SWQC. The soil and sediment ESCs are benchmark guidance values for ecological evaluation that were derived from numerous scientific studies and, with the exception of some ESCs that are based on the SWQC, are not remediation standards. ESC's are generally applied to samples obtained from within ESNR areas, but may also be used to screen data from non-ESNR locations. The SWQC are Remediation Standards that are applicable to surface water and are also used to evaluate ground water via monitoring wells located adjacent to surface water.

The applicable ESCs for COPECs identified for the Site are the NJDEP's 2009 ESCs from the EETG, including:

- Saline Estuary Sediment Criteria (Effects Range Low [ER-L], Effects Range Medium [ER-M]) (NJDEP-SRP Webpage; 2009);
- The NJDEP's 2009 ESC given as a range by NJDEP from low to high values, described in this report as Lower Ecological Soil Screening Levels (LSSLs); and Upper Ecological Soil Screening Levels (USSLs).
- SWQC and surrogate ESCs for Saline Estuary Aquatic Life Protection (acute and chronic) and Freshwater Aquatic Life Protection (SWQC; NJAC7:9B), as applicable based on site-specific salinity
- NJDEP EPH Guidance

Numerical ESCs for individual parameters and chemical constituents are included on the attached Tables II through XI.

The NJDEP's EPH guidance established 1,700 ppm EPH in soil and/or sediment as a conservative ecological ESC and 17,000 ppm as a screening level for the presence of free or residual product (defined in the TRSR as separate phase material [SPM]). For this investigation, EPH sediment concentrations that exceed 1,700 ppm are evaluated further based on individual petroleum constituent concentrations (i.e., VOCs and SVOCs). Also, EPH sediment concentrations that exceed 17,000 ppm may be further evaluated for SPM using lines of evidence as noted in the TRSR and sample grain-size distribution as indicated in the EPH guidance supporting documentation.

The ground water data from samples collected from monitoring wells adjacent to Woodbridge Creek and Arthur Kill were compared to the ESCs and aquatic life protection SWQC. The SWQC are adopted as remediation standards in the NJDEP regulations (NJAC7:26D) that include numeric standards for both protection of human health and aquatic life (*i.e.*, ecological receptors). The ESC are numeric guidance values that are screening levels, but may be adopted as remediation standards and/or used to identify contaminants in soil, sediment, surface water and adjacent ground water that require further evaluation.

The laboratory reported total ammonia nitrogen (TAN). However, the SWQC are based on the fraction of un-ionized ammonia. Therefore, the laboratory TAN sample results were converted to un-ionized ammonia concentrations from a site-specific pH and temperature data per the USEPA 1999 Update of Ambient Water Quality Criteria for Ammonia (EPA-822-R-99-014; December 1999). Site-specific SWQC were calculated based on pH and temperature in the surface water per the SWQC requirements.

The ESC and SWQC used in this report are included in Tables II through IX.

3.4 <u>Data Reliability and Influencing Factors</u>

The analytical methods used for the Supplemental EE were described in the laboratory analytical reports. Supplemental EE samples and analytical parameters are summarized in Table 1, and analytical results are included on Tables II through IX. A calculator for nitrogen ammonia is included as Appendix C. The analytical results are included on the electronic copy of the ERIR on the compact disks included as Appendix D.

Laboratory analysis of sediment samples obtained during March 2014 was performed in accordance with the TRSR. Laboratory sample analysis was completed by Accutest Laboratories of Dayton, New Jersey (Accutest), a New Jersey-certified laboratory.

A quality assurance review was performed for the laboratory analytical reports for the samples analyzed as part of the Supplemental EE. The method-specified calibrations and quality control performance criteria were met for the data generated during this investigation, except as indicated in the conformance/non-conformance summaries provided in the laboratory reports.

Based on a review of the laboratory reports, TRC did not further qualify or reject any data points. Therefore, these data are considered to be valid and useful for the intended data quality objectives and their intended purpose.

No significant events or seasonal variations are known to have influenced the sampling procedures or the results of the sampling programs presented in this Supplemental EE. However, it should be noted that in October 2012, Woodbridge Creek and the surrounding areas were significantly impacted by flooding due in part to an unusually large storm surge during Super Storm Sandy. While the effects of Sandy did not impact sampling procedures or data quality, it may have had some effect on the sample results included in this report due to potential environmental impacts from storm-related discharges of petroleum and/or related hazardous substances from facilities in the vicinity (e.g., Motiva Enterprises Diesel Spill).

4.0 SUPPLEMENTAL ECOLOGICAL EVALUATION

In response to NJDEP comments, Chevron collected additional sediment samples to 1) address areas where sediment core logs from the field activities conducted in 2002 for the RFI indicated possible free product; 2) further characterize background conditions; 3) update COPEC tables with most recent data, including CMS soil and ground water data; and 4) to define the physical down-stream sediment limit within the lower reach of Woodbridge Creek. This section presents the findings of the activities conducted during February and March 2014 sampling event.

Sediment sampling was performed in surface water bodies including Spa Spring and Woodbridge Creeks. Sediment sampling in Woodbridge Creek was conducted using barge-mounted drilling equipment, specifically Vibracore equipment. The barge and Vibracore drilling equipment was operated by Aqua Survey, Inc. (ASI) personnel. Sampling equipment was decontaminated between each location. Samples collected for laboratory analysis were transferred from the sampling tool to laboratory-supplied containers using dedicated, disposable scoops. Recovered cores were visually characterized, screened using a calibrated PID, and sampled at selected intervals and, depending on the location, the interval with the highest field-detectable evidence of contamination. Sediment sampling conducted in Spa Spring Creek was conducted using a hand driven sample corer. Sediment core logs are included as Appendix B.

4.1 Background Sediment Investigation

Due to the numerous surrounding industries upstream of the convergence of Spa Spring Creek and Woodbridge Creek, and the tidal nature of the Woodbridge Creek, and the location of the Arthur Kill, background sediment samples were organized into four groups; upgradient background samples from Woodbridge Creek, upgradient background samples in Spa Spring Creek, downgradient background samples collected from Woodbridge Creek and upgradient samples collected in the Arthur Kill.

4.1.1 Upstream Background Samples – Spa Spring Creek

During March 2014, Chevron collected 4 offsite background sample locations upgradient of the site, along Spa Spring Creek (Figure 3). Two samples of the background sample locations (SED-20-A and SED-20-C) were collected upgradient of a surface water drainage discharge pipe on opposite sides of the creek bank and two samples (SED -21-A and SED-21-C) were collected downgradient of the discharge pipe on opposite sides of the creek bank. The discharge pipe originates from a property located west of the Main Yard/North Field property line. The samples were collected in approximately 6 inches of water. The sediment layer in this area extended to approximately 6 inches below the sediment water interface. One sample was collected from each location from 0.0 to 0.5 feet below the sediment surface interface and analyzed for EPH, Target Analyte List/Target Compound List with a forward library search (TAL/TCL+30), total organic carbon (TOC) and grain size analysis by Accutest.

Location Name	Sample ID	Parameter analyzed for:
SED-20-A	SED-20-A/0-0.5	TAL/TCL+30, EPH, Grain size, TOC, pH
SED-20-B	SED-20-B/0-0.5	TAL/TCL+30, EPH, Grain size, TOC, pH
SED-21-A	SED-21-A/0-0.5	TAL/TCL+30, EPH, Grain size, TOC, pH
SED-21-B	SED-21-B/0-0.5	TAL/TCL+30, EPH, Grain size, TOC, pH

Sample results are presented on Tables II through IX and summarized on Figures 3 through 5. Sample results were also included as part of the COPEC tables provided in Section 4.4.1 of this report.

4.1.2 Downstream Samples – Woodbridge Creek

During March 2014, Chevron collected two sediment samples from the Woodbridge Creek downstream of the site (Figure 2). The samples were collected near the mouth of the creek as it enters into the Arthur Kill. One sample was collected toward the HESS property on the southern shore and one sample was collected in the middle of the creek. No sediment sample was collected from the northern side of the creek (Motiva Enterprises side), as the area is now covered with rip-rap, and was not able to be penetrated by the vibracore sediment sampling equipment.

Location Name	Sample ID	Parameter analyzed for:
SED-19-B	SED-19-B/6-6.5	TAL/TCL+30, EPH, Grain size, TOC, pH
SED-19-C	SED-19-C/7.5-8	TAL/TCL+30, EPH, Grain size, TOC, pH

Sample results are presented on Tables II through IX and summarized on Figures 3 through 5. Sample results were also included as part of the COPEC tables provided in this report.

4.2 Resampled Locations

In accordance with the October 11, 2010 *Chevron's Response to USEPA/NJDEP Comments on their Review of the Supplemental RCRA Facility Investigation Report* (February 2008) for the Chevron Perth Amboy Refinery, Chevron revisited former sampling location where elevated PID readings and possible product were observed during the original sediment investigation conducted in December 2002 and resample these areas using the NJDEPs EPH sampling method. Based on a review of the existing sediment core logs (Appendix B), TRC collected samples in March 2014 from the following locations:

Location	Sample	Reason For Re-Sampling	Parameter analyzed for:

Name	ID/Depth		
SED-02-A	SED-02-A/6-6.5	Elevated PID and Staining	EPH, Grain size, TOC, pH
SED-02-B	SED-02-B/3.5-4.0	Elevated PID and Staining	EPH, Grain size, TOC, pH
SED-03-B	SED-03-B/1.5-2.0 SED-03-B/4.5-5	Elevated PID and Staining	EPH, Grain size, TOC, pH
SED-03-C	SED-03-C/1.5-2.0 SED-03-C/6.0-6.5	Elevated PID and Staining	EPH, Grain size, TOC, pH
SED-04-C	SED-04-C/1.5-2.0	Elevated PID and Staining	EPH, Grain size, TOC, pH
SED-06-B	SED-06-B/4.0-4.5	Elevated PID and Staining	EPH, Grain size, TOC, pH
SED-09-A	SED-09-A/3.0-3.5	Elevated PID and Staining	EPH, Grain size, TOC, pH
SED-09-C	SED-09-C/4.5-5.0	Elevated PID and Staining	EPH, Grain size, TOC, pH

Sample results are presented on Tables II through IX and summarized on Figures 3 through 5. Please note that the revisited location of samples SB-02-A and SB-02-B were adjusted due to the presence of major subsurface utilities, including Kinder Morgan, Buckeye and Colonial Pipelines.

4.3 Contaminant of Potential Ecological Concern

The following sections include a re-evaluation of COPEC based on the existing site data, including the available CMS data and the recent supplemental data from sediment sampling as noted above. The data used for identification of COPECs included evaluation of site soil and ground water data from soil borings and wells located within 200 feet of each surface water body. The ground water data were compared to the NJDEP's ESCs and aquatic life protection SWQC to identify COPECs that have a potential to impact adjacent surface water bodies. Only COPECs that exceeded the SWQC in at least one or more of the samples were included. The sediment and surface water data used to identify COPECs in those media are based on data from sediment and surface water samples obtained from within the water bodies.

4.3.1 Spa Spring Creek

COPEC's were identified for Spa Spring Creek using site ground water and soil analytical results from samples collected within 200 feet of the creek, based on a review of background data and derived from review of site soil and ground water data. The sediment data COPEC review also incorporates the data collected from transects SED-11, SED-20 and SED-21 (located in the creek east of the Pennsylvania Rail Road crossing), which were considered background sample locations.

Spa Spring Creek – Adjacent Soil

Summary statistics for the COPECs identified in on-site soil samples within 200-feet of Spa Spring Creek are provided below:

	ESC				Background					Site Data Summary					Frequency					
Parameter (mg/kg)	LSSL	USSL	ER-L	ER-M	Literature Background Average	Literature 90th percentile	n of Background	Background Average Concentration	Background Max	n	# Detected	Avg. Conc.	Min. Conc.	Max. Conc.	#>LSSL	#>USSL	#>ER-L	#>ER-M	#>Literature Background Average	#>Literature 90th percentile
bis(2-Ethylhexyl)phthalate	0.925	--	0.18216	2.64651	--	--	5	0.21	0.476	81	11	0.04	0	0.7	0	NA	4	0	NA	NA
Acenaphthene	20	--	0.016	0.5	--	--	5	0.05	0.235	72	6	0.12	0	4.7	0	NA	6	4	NA	NA
Acenaphthylene	682	--	0.044	0.64	--	--	5	0	0	72	1	0.04	0	2.7	0	NA	1	1	NA	NA
Anthracene	1480	--	0.085	1.1	--	--	5	0.09	0.277	85	19	0.99	0	13	0	NA	17	11	NA	NA
Benzo(a)pyrene	1.52	--	0.43	1.6	--	--	5	0.24	0.465	83	24	0.83	0	8.89	11	NA	16	11	NA	NA
Benzo(a)anthracene	5.21	--	0.261	1.6	--	--	5	0.23	0.475	84	23	1.00	0	12	7	NA	16	13	NA	NA
Benzo(ghi)perylene	119	--	0.17	--	--	--	5	0.18	0.317	72	15	0.22	0	4.6	0	NA	8	NA	NA	NA
Chrysene	4.73	--	0.384	2.8	--	--	5	0.32	0.601	84	28	1.26	0	15	8	NA	16	13	NA	NA
Dibenz(a,h)anthracene	18.4	--	0.063	0.26	--	--	5	0.04	0.0816	83	6	0.02	0	0.75	0	NA	5	2	NA	NA
Fluorene	122	--	0.019	0.54	--	--	5	0.05	0.208	72	11	0.24	0	9.1	0	NA	10	5	NA	NA
Indeno(1,2,3-cd)pyrene	109	--	0.2	--	--	--	5	0.17	0.32	72	8	0.08	0	3	0	NA	4	NA	NA	NA
Phenanthrene	45.7	--	0.24	1.5	--	--	5	0.40	1.15	85	32	4.85	0	63	4	NA	22	17	NA	NA
Total PAHs	--	--	4	45	--	--	5	3.46	7.9876	79	31	26.0	0	696.1	NA	NA	14	6	NA	NA
Aluminum	50	--	--	18000	6800	10800	5	10718	27100	67	67	20132	944	59582.5	67	NA	NA	34	57	48
Arsenic	9.9	46	8.2	70	5.2	13.6	5	7.92	11.3	77	73	12.5	0	63.5	36	2	42	0	53	20
Barium	283	2000	--	48	28.3	65.8	5	25.5	71.1	72	72	86.6	8.78	203	0	0	NA	60	68	35
Cadmium	0.36	140	1.2	9.6	*0.5*	*0.5*	5	0.32	1.6	72	18	0.26	0	2.6	15	0	5	0	14	14
Chromium	0.4	1	81	370	11.8	34.7	5	25.1	37.7	72	72	36.8	5.5	139.835	72	72	3	0	69	34
Cobalt	0.14	230	--	10	*5*	*5*	5	14.4	18.8	72	67	9.81	0	37.5	67	0	NA	34	57	57
Copper	5.4	100	34	270	9.3	33.3	5	31.5	41.4	67	65	86.3	0	1240	64	15	28	4	60	28
Lead	0.0537	1700	47	218	37.6	144	5	34.8	42.4	75	72	103	0	903	72	0	33	10	34	15
Manganese	220	4300	--	260	62.4	206	5	237	423	67	67	237	29.9	718	31	0	NA	24	62	32
Mercury	0.0005	0.3	0.15	0.71	*0.1*	0.21	5	0	0	70	37	0.42	0	9.2	37	15	22	8	25	19
Nickel	13.6	280	21	52	*4*	12.3	5	24.0	32.9	72	71	31.6	0	155	54	0	44	10	70	57
Selenium	0.0276	4.1	--	1	*1*	*1*	5	0	0	72	29	1.12	0	8.23	29	7	NA	21	21	21
Silver	2	560	1	3.7	*1*	*1*	5	0.70	1.2	67	5	0.07	0	2.4	1	0	2	0	2	2
Vanadium	2	280	--	57	16	35.5	5	33.3	54.9	72	68	82.7	0	766	68	3	NA	32	65	49
Zinc	6.62	160	150	410	39.9	106	5	252	664	67	66	126	0	636.592	66	13	14	3	54	22

The data for soil samples collected within 200 feet of Spa Spring indicate that the COPECs include Polycyclic Aromatic Hydrocarbons (PAHs) and metals.

Spa Spring Creek - Adjacent Ground Water

Summary statistics of the COPECs identified in on-site ground water samples from within 200-feet of Spa Spring Creek are provided below:

	ESC		Site Data Summary					Frequency	
Parameter (µg/l)	**SW Saline Chronic**	**SW Saline Acute**	**n**	**# Detected**	**Avg. Conc.**	**Min. Conc.**	**Max. Conc.**	**#>SW Saline Chronic**	**#>SW Saline Acute**
Copper (U)	3.1	4.8	56	36	5.05	0	37.8	30	25
Nickel (U)	22	64	56	40	57.3	0	714	25	15
Zinc (U)	81	90	54	32	31.2	0	361	4	4

(U) = Unfiltered Ground water sample
(F) = Groundwater sample filtered through 0.45 micron high capacity water filter

The data collected from the monitoring wells around Spa Spring Creek indicate that ground water COPECs detected above the SWQC in the vicinty of Spa Spring Creek were limited to copper, nickel and zinc. It should be noted that the results for copper, lead, nickel and zinc are from unfiltered samples and no filtered data are available. The SWQC for these constituents are based on dissolved concentrations. In addition, metal concentrations in ground water are normally attributed to particulates in the water. Therefore, identification of the total copper,nickel and zinc as COPECs is considered conservative.

<u>Spa Spring Creek - Sediment</u>

Summary statistics for the COPECs identified in sediments are provided below.

	ESC		Background			Site Data Summary					Frequency			
Parameter (mg/kg)	ER-L	ER-M	n of Background	Background Average Concentration	Background Max	n	# Detected	Avg. Conc.	Min. Conc.	Max. Conc.	#>ER-L	#>ER-M	#>Background Average Concentration	#>Background Max
bis(2-Ethylhexyl)phthalate	0.1822	2.6465	5	0.21	0.476	5	2	0.27	0	0.86	2	0	2	2
Acenaphthene	0.016	0.5	5	0.05	0.235	5	3	0.0066	0	0.017	1	0	0	0
Acenaphthylene	0.044	0.64	5	0	0	5	2	0.02	0	0.083	1	0	2	2
Anthracene	0.085	1.1	5	0.09	0.277	5	3	0.04	0	0.13	1	0	2	2
Benzo(a)pyrene	0.43	1.6	5	0.24	0.465	5	4	0.14	0	0.45	1	0	1	0
Benzo(a)anthracene	0.261	1.6	5	0.23	0.475	5	3	0.09	0	0.29	1	0	1	0
Benzo(ghi)perylene	0.17	–	5	0.18	0.317	5	4	0.20	0	0.74	2	NA	2	1
Chrysene	0.384	2.8	5	0.32	0.601	5	5	0.14	0.017	0.39	1	0	1	0
Dibenz(a,h)anthracene	0.063	0.26	5	0.04	0.0816	5	3	0.04	0	0.15	1	0	2	1
Fluorene	0.019	0.54	5	0.05	0.208	5	3	0.01	0	0.031	1	0	0	0
Indeno(1,2,3-cd)pyrene	0.2	–	5	0.17	0.32	5	4	0.12	0	0.37	1	NA	2	1
Phenanthrene	0.24	1.5	5	0.40	1.15	5	5	0.11	0.018	0.31	1	0	0	0
Total PAHs	4	45	5	3.46	7.9876	5	5	1.63	0.135	4.891	1	0	1	0
Aluminum	–	18000	5	10718	27100	5	5	15934	7270	24300	NA	2	4	0
Arsenic	8.2	70	5	7.92	11.3	5	5	40.1	6.2	164	4	1	4	1
Barium	–	48	5	25.5	71.1	5	5	79.3	43.4	165	NA	4	5	2
Cadmium	1.2	9.6	5	0.32	1.6	5	4	1.14	0	2.5	2	0	4	1
Chromium	81	370	5	25.1	37.7	5	5	46.0	15	133	1	0	4	1
Cobalt	–	10	5	14.4	18.8	5	5	17.7	5.1	36.7	NA	4	3	1
Copper	34	270	5	31.5	41.4	5	5	126	8.2	494	2	1	3	2
Lead	47	218	5	34.8	42.4	5	5	147	7.7	656	1	1	2	1
Manganese	–	260	5	237	423	5	5	457	141	1230	NA	3	3	2
Mercury	0.15	0.71	5	0	0	5	1	0.52	0	2.6	1	1	1	1
Nickel	21	52	5	24.0	32.9	5	5	48.7	17	85.1	4	2	4	3
Selenium	–	1	5	0	0	5	1	2.60	0	13	NA	1	1	1
Silver	1	3.7	5	0.70	1.2	5	1	0.42	0	2.1	1	0	1	1
Vanadium	–	57	5	33.3	54.9	5	5	54.2	30	109	NA	1	4	1
Zinc	150	410	5	252	664	5	5	398	58.4	1140	2	2	2	1

The data from the samples collected from the sediment of Spa Spring Creek indicate that sediment COPECs detected above the ER-L and ER-M include PAHs and metals.

In addition, none of the four background samples collected from Spa Spring Creek had EPH concetrations greater than the ESC of 1,700 ppm. As discussed above, no further action is required for these samples.

<u>Spa Spring Creek - Surface Water</u>
Summary statistics for the COPECs identified in surface water are provided below:

Parameter (µg/l)	ESC		Site Data Summary					Frequency	
	SW Saline Chronic	SW Saline Acute	n	# Detected	Avg. Conc.	Min. Conc.	Max. Conc.	#>SW Saline Chronic	#>SW Saline Acute
Copper (U)	3.1	4.8	3	2	3.00	0	5.4	2	1
Nickel (U)	22	64	3	3	35.2	30.9	37.7	3	0
Zinc (U)	81	90	3	3	122	103	134	3	3

(U) = Unfiltered Ground water sample
(F) = Groundwater sample filtered through 0.45 micron high capacity water filter

The data collected from Spa Spring Creek indicate that surface water COPECs detected above the SWQC in the vicinty of Spa Spring Creek were limited to copper, nickel and zinc. Of these compounds only nickel was detected in the shallow monitoring wells along the property boundary. It is important to note that although no background surface water samples were collected in Spa Spring Creek, nickel was detected at elevated concentrations in background sediment samples SED-20-A and SED-20-C.

It should be noted that the results for copper, nickel and zinc are from unfiltered samples and no filtered data are available. The SWQC for these constituents are based on dissolved concentrations. In addition, metal concentrations in surface water are normally attributed to suspended particulates in the water. Therefore, identification of the total copper, nickel and zinc as COPECs is considered conservative.

4.3.2 Woodbridge Creek

COPEC's were identified for Woodbridge Creek using site ground water and soil analytical results from samples collected within 200 feet of the creek. COPECs were identified in sediment and surface water using the existing surface water sample data, and existing and recent sediment data, based on a review of background data and COPECs identified from review of site soil and ground water data.

Woodbridge Creek – Adjacent Soil

Summary statistics for the COPECs identified in on-site soil samples within 200-feet of Woodbridge Creek are provided below:

Parameter (mg/kg)	ESC				Background		Site Data Summary					Frequency					
	LSSL	USSL	ER-L	ER-M	Literature Background Average	Literature 90th percentile	n	# Detected	Avg. Conc.	Min. Conc.	Max. Conc.	#>LSSL	#>USSL	#>ER-L	#>ER-M	#>Literature Background Average	#>Literature 90th percentile
1,2-Dichlorobenzene	2.96	–	–	0.013	–	–	199	1	0.0016	0	0.32	0	NA	NA	1	NA	NA
1,4-Dichlorobenzene	0.546	20	–	0.11	–	–	199	1	0.0007	0	0.134	0	0	NA	1	NA	NA
Benzene	0.255	–	0.34	–	–	–	168	49	110	0	6200	40	NA	34	NA	NA	NA
Ethylbenzene	5.16	–	1.4	–	–	–	170	55	9.92	0	440	18	NA	24	NA	NA	NA
Toluene	200	–	2.5	–	–	–	167	39	19.6	0	920	6	NA	12	NA	NA	NA
Xylenes (total)	10	–	0.12	–	–	–	170	70	63.0	0	2200	22	NA	65	NA	NA	NA
2,4-Dimethyl phenol	0.01	–	–	–	–	–	131	6	0.18	0	17	6	NA	NA	NA	NA	NA
Phenol	30	120	–	0.13	–	–	131	3	0.07	0	8.2	0	0	NA	2	NA	NA
bis(2-Ethylhexyl)phthalate	0.925	–	0.1822	2.6465	–	–	135	31	0.32	0	13	7	NA	21	3	NA	NA
Butyl benzyl phthalate	0.239	–	–	0.063	–	–	135	1	0.0089	0	1.2	1	NA	NA	1	NA	NA
Acenaphthene	20	–	0.016	0.5	–	–	133	35	0.61	0	24	1	NA	32	15	NA	NA
Acenaphthylene	682	–	0.044	0.64	–	–	133	19	0.24	0	18	0	NA	14	6	NA	NA
Anthracene	1480	–	0.085	1.1	–	–	141	45	0.69	0	30	0	NA	35	11	NA	NA
Benzo(a)pyrene	1.52	–	0.43	1.6	–	–	158	56	0.44	0	12.7	9	NA	16	9	NA	NA
Benzo(a)anthracene	5.21	–	0.261	1.6	–	–	158	59	0.57	0	17	4	NA	31	13	NA	NA
Benzo(b)fluoranthene	59.8	–	–	1.8	–	–	158	58	0.39	0	10	0	NA	NA	11	NA	NA
Benzo(ghi)perylene	119	–	0.17	–	–	–	134	42	0.33	0	6.4	0	NA	28	NA	NA	NA
Benzo(k)fluoranthene	148	–	0.24	–	–	–	141	31	0.08	0	3.6	0	NA	10	NA	NA	NA
Chrysene	4.73	–	0.384	2.8	–	–	158	67	1.00	0	21	10	NA	37	13	NA	NA
Dibenz(a,h)anthracene	18.4	–	0.063	0.26	–	–	157	20	0.03	0	2.1	0	NA	14	5	NA	NA
Fluoranthene	122	–	0.6	5.1	–	–	141	66	0.94	0	28	0	NA	27	9	NA	NA
Fluorene	122	–	0.019	0.54	–	–	133	37	1.30	0	58	0	NA	35	19	NA	NA
Indeno(1,2,3-cd)pyrene	109	–	0.2	–	–	–	133	25	0.07	0	2.2	0	NA	11	NA	NA	NA
2-Methylnaphthalene	3.24	–	0.07	0.67	–	–	135	42	3.97	0	190	18	NA	35	26	NA	NA
Naphthalene	0.0994	–	0.16	2.1	–	–	155	51	8.01	0	450	38	NA	35	21	NA	NA
Phenanthrene	45.7	–	0.24	1.5	–	–	141	72	4.21	0	170	5	NA	46	29	NA	NA
Pyrene	78.5	–	0.665	2.6	–	–	142	78	2.12	0	46	0	NA	38	16	NA	NA
Total PAHs	–	–	4	45	–	–	150	91	21.7	0	830.5	NA	NA	44	13	NA	NA
4,4'-DDD	0.758	–	0.002	0.02	0.0227	–	13	3	0.0010	0	0.0072	0	NA	2	0	0	NA
4,4'-DDT	0.0035	–	0.001	0.007	0.0789	–	13	3	0.0004	0	0.0022	0	NA	2	0	0	NA
DDT (Total)	0.021	0.093	0.0016	0.046	–	–	13	4	0.0014	0	0.0073	0	0	4	0	NA	NA
Aroclor 1248	–	–	0.03	–	–	–	13	1	0.01	0	0.15	NA	NA	1	NA	NA	NA
Total PCBs	0.0003	40	0.023	0.18	–	–	13	1	0.01	0	0.15	1	0	1	0	NA	NA
Aluminum	50	–	–	18000	6800	10800	142	142	24985	3590	125000	142	NA	NA	74	132	108
Antimony	0.27	78	–	9.3	6	6	139	32	1.43	0	89.1	32	1	NA	4	9	9
Arsenic	9.9	46	8.2	70	5.2	13.6	166	166	22.6	2.38	422	94	15	108	8	132	59
Barium	283	2000	–	48	28.3	65.8	144	144	82.9	10.9	419	2	0	NA	107	138	72
Cadmium	0.36	140	1.2	9.6	0.5	0.5	135	64	0.51	0	6.87	53	0	22	0	47	47
Chromium	0.4	1	81	370	11.8	34.7	160	160	36.1	6.06	115	160	160	5	0	156	71
Cobalt	0.14	230	–	10	5	5	144	144	12.1	1.8	82.6	144	0	NA	72	127	127
Copper	5.4	100	34	270	9.3	33.3	148	147	218	0	3690	140	54	80	28	136	80
Lead	0.0537	1700	47	218	37.6	144	279	279	4038	3.5	142000	279	30	163	94	182	111
Manganese	220	4300	–	260	62.4	206	142	142	284	27.2	2240	72	0	NA	62	134	74
Mercury	0.0005	0.3	0.15	0.71	0.1	0.21	140	104	0.67	0	9.22	104	41	64	22	69	58
Nickel	13.6	280	21	52	4	12.3	160	160	70.5	5.63	1110	136	13	111	29	160	141
Selenium	0.0276	4.1	–	1	1	1	139	48	0.94	0	12.4	48	8	NA	37	37	37
Silver	2	560	1	3.7	1	1	137	45	0.26	0	3.6	2	0	12	0	12	12
Vanadium	2	280	–	57	16	35.5	144	144	304	12.5	4380	144	21	NA	76	142	114
Zinc	6.62	160	150	410	39.9	106	142	142	265	14.1	6320	142	36	39	11	118	56

The data for soil samples collected within 200 feet of Woodbridge Creek indicate that the COPECs include VOCs (mostly Benzene, Toluene, Ethylbenzene, and Xylene (BTEX) compounds), SVOCs (mostly PAHs), and metals. Please note that Polychlorinated Biphenyls (PCBs) were detected in less than 10% of the soil samples collected on-site, and is not considered a COPEC.

Woodbridge Creek – Adjacent Ground Water

Summary statistics of the COPECs identified in on-site ground water samples from within 200-feet of Woodbridge Creek are provided below:

	ESC		Background			Site Data Summary					Frequency			
Parameter (µg/l)	**SW Saline Chronic**	**SW Saline Acute**	**n of Background**	**Background Average Concentration**	**Background Max**	**n**	**# Detected**	**Avg. Conc.**	**Min. Conc.**	**Max. Conc.**	**#>SW Saline Chronic**	**#>SW Saline Acute**	**#>Background Average Concentration**	**#>Background Max**
Copper (U)	3.1	4.8	9	14.3	22.1	108	71	6.68	0	139	50	37	11	7
Nickel (U)	22	64	9	28.0	51.5	108	77	55.9	0	1330	26	13	20	15
Zinc (U)	81	90	9	55.0	92.2	107	46	106	0	3080	13	13	19	13

(U) = Unfiltered Ground water sample
(F) = Groundwater sample filtered through 0.45 micron high capacity water filter

The data collected from the monitoring wells around Woodbridge Creek indicate that ground water COPECs detected above the SWQC in the vicinity of Spa Spring Creek were limited to ammonium copper, nickel, and zinc.

It should be noted that the results for copper, lead, nickel, silver and zinc are from unfiltered samples and no filtered data are available. The SWQC for these constituents are based on dissolved concentrations. In addition, metal concentrations in ground water are normally attributed to particulates in the water. Therefore, identification of the total copper, lead, nickel, silver and zinc results as COPECs is considered conservative.

Nitrogen ammonia was not detected above the SWQC in any of the surface water samples collected from Woodbridge Creek as shown below. Therefore, Nitrogen ammonia will not be retained as a COPEC.

Phosphorus (yellow) was detected in 15 of the 33 wells in which it was analyzed, only one of which was within 200 ft of Woodbridge Creek. Concetrations of phosphorus (yellow) ranged from ND to 6,900 ppm. It will be retained as a COPEC.

Woodbridge Creek - Sediment

Summary statistics for the COPECs identified in sediments are provided below:

	ESC		Background			Site Data Summary					Frequency			
Parameter (mg/kg)	ER-L	ER-M	n of Background	Background Average Concentration	Background Max	n	# Detected	Avg. Conc.	Min. Conc.	Max. Conc.	#>ER-L	#>ER-M	#>Background Average Concentration	#>Background Max
1,2,4-Trichlorobenzene	–	0.0048	3	0	0	27	1	0.0078	0	0.21	NA	1	1	1
1,2-Dichlorobenzene	–	0.013	3	0	0	27	1	0.0029	0	0.0781	NA	1	1	1
1,4-Dichlorobenzene	–	0.11	3	0	0	27	2	0.05	0	0.971	NA	2	2	2
Benzene	0.34	–	3	0	0	27	6	1.56	0	20	5	NA	6	6
Ethylbenzene	1.4	–	3	0	0	27	6	0.76	0	6.6	4	NA	6	6
Toluene	2.5	–	3	0	0	27	5	0.19	0	2.9	1	NA	5	5
Xylenes (total)	0.12	–	3	0	0	27	7	3.81	0	29	7	NA	7	7
bis(2-Ethylhexyl)phthalate	0.1822	2.6465	3	2.22	5.2	27	25	7.95	0	50	23	14	15	9
Butyl benzyl phthalate	--	0.063	3	0	0	27	1	0.0093	0	0.25	NA	1	1	1
Acenaphthene	0.016	0.5	3	0.02	0.052	27	24	0.36	0	2.8	21	5	21	16
Acenaphthylene	0.044	0.64	3	0.02	0.027	27	25	0.17	0	1.2	20	2	22	20
Anthracene	0.085	1.1	3	0.09	0.19	27	27	0.71	0.003	3.55	23	6	22	20
Benzo(a)pyrene	0.43	1.6	3	0.35	0.65	27	27	2.01	0.01	10.6	20	8	22	18
Benzo(a)anthracene	0.261	1.6	3	0.33	0.63	27	27	1.45	0.0081	7.03	23	8	22	16
Benzo(b)fluoranthene	–	1.8	3	0.55	1.1	25	25	1.93	0.017	6.94	NA	8	21	16
Benzo(ghi)perylene	0.17	–	3	0.16	0.21	27	27	2.23	0.011	14	24	NA	24	23
Benzo(k)fluoranthene	0.24	–	3	0.18	0.34	27	27	0.47	0.0056	1.3	18	NA	22	17
Chrysene	0.384	2.8	3	0.46	1	27	27	2.24	0.011	11.7	22	5	22	16
Dibenz(a,h)anthracene	0.063	0.26	3	0.05	0.073	27	27	0.53	0.0018	3.1	22	11	24	20
Fluoranthene	0.6	5.1	3	0.54	1.1	27	27	1.99	0.021	6.63	23	1	23	15
Fluorene	0.019	0.54	3	0.03	0.074	27	25	0.66	0	5.8	21	6	19	12
Indeno(1,2,3-cd)pyrene	0.2	–	3	0.15	0.22	27	27	0.87	0.0076	3.6	20	NA	23	20
2-Methylnaphthalene	0.07	0.67	3	0.07	0.22	27	26	3.60	0	39	10	7	10	7
Naphthalene	0.16	2.1	3	0.07	0.22	28	25	3.87	0	80	9	7	14	8
Phenanthrene	0.24	1.5	3	0.34	0.77	27	27	3.14	0.011	19.2	19	10	16	12
Pyrene	0.665	2.6	3	0.70	1.4	27	27	3.63	0.027	13.1	24	12	24	19
Total PAHs	4	45	3	4.11	8.276	27	27	26.9	0.1473	115.862	23	5	23	18
4,4'-DDD	0.002	0.02	NS	NA	NA	2	2	0.94	0.0558	1.83	2	2	NA	NA
4,4'-DDE	0.0022	0.027	NS	NA	NA	2	2	0.20	0.104	0.302	2	2	NA	NA
Chlordane (alpha and gamma)	0.007	–	NS	NA	NA	2	1	0.0096	0	0.0191	1	NA	NA	NA
DDT (Total)	0.0016	0.046	NS	NA	NA	2	2	1.15	0.1598	2.132	2	2	NA	NA
Heptachlor	--	0.0003	NS	NA	NA	2	1	0.0052	0	0.0103	NA	1	NA	NA
Heptachlor epoxide	0.005	–	NS	NA	NA	2	1	0.02	0	0.0427	1	NA	NA	NA
Aroclor 1248	0.03	–	NS	NA	NA	2	2	3.27	2.57	3.96	2	NA	NA	NA
Aroclor 1254	0.06	–	NS	NA	NA	2	2	3.46	2.91	4.01	2	NA	NA	NA
Total PCBs	0.023	0.18	NS	NA	NA	2	2	6.73	6.58	6.87	2	2	NA	NA
Aluminum	--	18000	3	4003	4320	26	26	15207	5860	30400	NA	13	26	26
Antimony	--	9.3	3	2.63	7.9	26	8	1.10	0	9.5	NA	1	4	1
Arsenic	8.2	70	3	5.03	5.3	26	26	30.6	5.8	91.7	23	1	26	26
Barium	--	48	3	13.7	18	26	26	99.1	17.1	272	NA	18	26	25
Cadmium	1.2	9.6	3	0.34	0.52	26	26	4.20	0.68	13	19	4	26	26
Chromium	81	370	3	14.1	18	26	26	70.7	20.5	166	9	0	26	26

Parameter (mg/kg)	ESC		Background			Site Data Summary					Frequency			
	ER-L	ER-M	n of Background	Background Average Concentration	Background Max	n	# Detected	Avg. Conc.	Min. Conc.	Max. Conc.	#>ER-L	#>ER-M	#>Background Average Concentration	#>Background Max
Cobalt	–	10	3	7.40	8.3	26	25	16.0	0	85.9	NA	16	21	21
Copper	34	270	3	67.5	85.7	26	26	766	17.7	8030	25	19	24	24
Lead	47	218	3	65.8	110	26	26	195	13.5	817	24	9	21	16
Manganese	–	260	3	73.1	75.9	26	26	218	77.1	429	NA	9	26	26
Mercury	0.15	0.71	3	0	0	26	26	1.77	0.03	7.1	22	14	26	26
Nickel	21	52	3	31.2	33.7	26	26	192	28.6	2480	26	18	24	24
Selenium	–	1	3	0	0	26	25	19.8	0	154	NA	25	25	25
Silver	1	3.7	3	0.06	0.17	26	24	1.90	0	5.4	15	6	24	24
Vanadium	–	57	3	35.3	75.2	26	26	53.0	22.6	100	NA	12	18	3
Zinc	150	410	3	363	457	26	26	477	88.9	2970	24	11	12	10

The data from the samples collected from the sediment of Woodbridge Creek indicate that sediment COPECs detected above the ER-L and ER-M include EPH, VOCs (mostly BTEX compounds), SVOCs (mostly PAHs), pesticides, PCBs and metals. PCBs are not retained as a COPEC because they are detected in less than 10% of the soil samples collected on the entire site and are therefore not considered a contaminant of concern at the site.

Summary statistics of the analytical results for EPH detected in sediment:

Parameter (mg/kg)	ESC	SPM Screening Level	n	# Detected	Frequency of # Detected	Avg. Conc.	Min. Conc.	Max. Conc.	#>ESC	Frequency of #>ESC	#>SPM	Frequency of #>SPM
EPH	1700	17000	12	12	100%	16270	1640	59300	11	92%	3	25%

Eleven of the 12 EPH samples collected from Woodbridge Creek had concentrations greater than the ESC. These samples were evaluated further based upon individual petroleum constituent concentrations. Of the 11 samples that exceeded the ESC, only three samples had concentrations greater than 17,000 ppm (SED-02-A/6.0-6.5, SED-03-C/1.5-2.0 and SED-09-C/4.5-5.0).

Woodbridge Creek - Surface Water

Summary statistics for the COPECs identified in surface water are provided below:

	ESC		Site Data Summary					Frequency	
Parameter (µg/l)	**SW Saline Chronic**	**SW Saline Acute**	**n**	**# Detected**	**Avg. Conc.**	**Min. Conc.**	**Max. Conc.**	**#>SW Saline Chronic**	**#>SW Saline Acute**
Copper (U)	3.1	4.8	9	9	14.3	3.6	22.1	9	8
Nickel (U)	22	64	9	9	28.0	3.2	51.5	6	0
Zinc (U)	81	90	9	9	55.0	14.6	92.2	1	1

(U) = Unfiltered Ground water sample
(F) = Groundwater sample filtered through 0.45 micron high capacity water filter

The data collected from the surface water around Woodbridge Creek indicate that surface water COPECs detected above the SWQC in the vicinty of Spa Spring Creek were limited to copper, nickel and Zinc.

It should be noted that the results for copper, nickel, and zinc are from unfiltered samples and no filtered data are available. The SWQC for these constituents are based on dissolved concentrations. In addition, metal concentrations in ground water are normally attributed to suspended particulates in the water. Therefore, identification of the total copper, nickel and zinc results as COPECs is considered conservative.

4.3.3 Arthur Kill

COPEC's were identified for the Arthur Kill using site ground water and soil analytical results from samples collected within 200 feet of the waterway. COPECs were identified in sediment using the existing surface water sample data, and existing and recent sediment data, based on a review of background data and COPECs identified from review of site soil and ground water data.

Sediment samples collected from SED-16-C and SED-17-C were considered background samples for the creation of the tables.

Arthur Kill Soil

Summary statistics for the COPECs identified in on-site soil samples within 200-feet of the Arthur Kill are provided below:

	ESC				Background		Site Data Summary					Frequency					
Parameter (mg/kg)	**LSSL**	**USSL**	**ER-L**	**ER-M**	**Literature Background Average**	**Literature 90th percentile**	**n**	**# Detected**	**Avg. Conc.**	**Min. Conc.**	**Max. Conc.**	**#>LSSL**	**#>USSL**	**#>ER-L**	**#>ER-M**	**#>Literature Background Average**	**#>Literature 90th percentile**
bis(2-Ethylhexyl)phthalate	0.925	–	0.1822	2.6465	–	–	150	44	11.7	0	1300	25	NA	38	18	NA	NA
Acenaphthene	20	–	0.016	0.5	–	–	125	67	1.93	0	110	1	NA	67	39	NA	NA
Acenaphthylene	682	–	0.044	0.64	–	–	125	39	0.24	0	3.8	0	NA	30	15	NA	NA
Anthracene	1480	–	0.085	1.1	–	–	156	74	2.25	0	170	0	NA	62	28	NA	NA
Benzo(a)pyrene	1.52	–	0.43	1.6	–	–	156	79	1.56	0	100	19	NA	45	18	NA	NA
Benzo(a)anthracene	5.21	–	0.261	1.6	–	–	156	84	1.74	0	120	10	NA	55	22	NA	NA
Benzo(ghi)perylene	119	–	0.17	–	–	–	125	63	1.11	0	46	0	NA	42	NA	NA	NA
Benzo(k)fluoranthene	148	–	0.24	–	–	–	156	50	0.42	0	42	0	NA	23	NA	NA	NA
Chrysene	4.73	–	0.384	2.8	–	–	156	94	2.12	0	110	15	NA	58	19	NA	NA
Dibenz(a,h)anthracene	18.4	–	0.063	0.26	–	–	156	38	0.19	0	11	0	NA	28	18	NA	NA
Fluoranthene	122	–	0.6	5.1	–	–	156	99	4.01	0	390	1	NA	50	11	NA	NA
Fluorene	122	–	0.019	0.54	–	–	125	70	3.51	0	160	1	NA	69	44	NA	NA
Indeno(1,2,3-cd)pyrene	109	–	0.2	–	–	–	125	53	0.70	0	54	0	NA	29	NA	NA	NA
2-Methylnaphthalene	3.24	–	0.07	0.67	–	–	132	77	65.6	0	1400	38	NA	74	54	NA	NA
Phenanthrene	45.7	–	0.24	1.5	–	–	156	106	9.93	0	630	2	NA	86	58	NA	NA
Pyrene	78.5	–	0.665	2.6	–	–	156	102	4.16	0	280	1	NA	63	32	NA	NA
Total PAHs	–	–	4	45	–	–	191	143	135	0	3069.73	NA	NA	89	50	NA	NA
Aluminum	50	–	–	18000	6800	10800	101	101	12230	0.176	33100	100	NA	NA	27	67	53
Arsenic	9.9	46	8.2	70	5.2	13.6	132	119	21.9	0	256	74	16	84	7	99	66
Barium	283	2000	–	48	28.3	65.8	116	112	71.1	0	429	2	0	NA	82	94	54
Cadmium	0.36	140	1.2	9.6	*0.5*	*0.5*	116	67	0.97	0	20.6	53	0	27	1	47	47
Chromium	0.4	1	81	370	11.8	34.7	115	109	30.0	0	168	109	109	6	0	87	36
Cobalt	0.14	230	–	10	*5*	*5*	116	109	8.57	0	38.4	109	0	NA	34	82	82
Copper	5.4	100	34	270	9.3	33.3	101	100	333	0	3850	85	52	63	30	82	64
Lead	0.0537	1700	47	218	37.6	144	189	178	16056	0	752000	178	43	117	73	119	87
Manganese	220	4300	–	260	62.4	206	101	101	333	0.0026	2470	50	0	NA	42	80	50
Mercury	0.0005	0.3	0.15	0.71	*0.1*	0.21	115	75	0.34	0	12.2	75	27	39	11	48	32
Nickel	13.6	280	21	52	*4*	12.3	116	108	31.3	0	217	90	0	59	15	101	94
Selenium	0.0276	4.1	–	1	*1*	*1*	116	49	1.19	0	8.21	49	6	NA	44	44	44
Silver	2	560	1	3.7	*1*	*1*	101	69	0.81	0	5.18	14	0	30	1	30	30
Vanadium	2	280	–	57	16	35.5	116	112	44.4	0	484	111	2	NA	23	93	53
Zinc	6.62	160	150	410	39.9	106	101	101	164	0.0126	1020	97	32	34	7	72	43

The data for soil samples collected with 200 feet of the western bank of the Arthur Kill indicate that the COPECs include BTEX compounds, SVOCs (including PAHs) and metals.

Arthur Kill Ground Water

Summary statistics of the COPECs identified in on-site ground water samples from within 200-feet of the Arthur Kill are provided below:

Parameter (µg/l)	ESC		Site Data Summary					Frequency	
	SW Saline Chronic	SW Saline Acute	n	# Detected	Avg. Conc.	Min. Conc.	Max. Conc.	#>SW Saline Chronic	#>SW Saline Acute
Arsenic (U)	36	69	54	33	73.8	0	497	19	17
Arsenic (F)	36	69	1	1	382	382	382	1	1
Cadmium (U)	8.8	40	47	20	2.62	0	19.2	7	0
Copper (U)	3.1	4.8	47	21	4.73	0	53.1	18	14
Lead (U)	24	210	63	21	17.2	0	247	8	2
Nickel (U)	22	64	47	26	338	0	3920	16	11
Zinc (U)	81	90	43	24	336	0	3880	14	14
Nitrogen, Ammonium	*	*	41	26	0.04	0	1.6332	1	4

(U) = Unfiltered Ground water sample
(F) = Groundwater sample filtered through 0.45 micron high capacity water filter
* Calculated value that varies per sample see Appendix C

The data collected from the monitoring wells within 200 feet of the western bank of the Arthur Kill indicate that ground water COPECs detected above the SWQC in the vicinity of Spa Spring Creek were limited to ammonium nitrogen and metals including arsenic, cadmium, copper, lead, nickel and Zinc.

Other than one arsenic sample, the results for metals, including cadmium, copper, lead, nickel, and zinc are from unfiltered samples and no filtered data are available. The SWQC for these constituents are based on dissolved concentrations. In addition, metal concentrations in ground water are normally attributed to particulates in the water. Therefore, identification of the total arsenic, cadmium, copper, lead, nickel and zinc results as COPECs is considered conservative.

<u>Arthur Kill Sediment</u>

Summary statistics for the COPECs identified in sediments are provided below:

	ESC		Background			Site Data Summary					Frequency			
Parameter (mg/kg)	ER-L	ER-M	n of Background	Background Average Concentration	Background Max	n	# Detected	Avg. Conc.	Min. Conc.	Max. Conc.	#>ER-L	#>ER-M	#>Background Average Concentration	#>Background Max
bis(2-Ethylhexyl)phthalate	0.1822	2.6465	2	10.5	21	4	4	4.20	3.7	4.7	4	4	0	0
Acenaphthene	0.016	0.5	2	1.96	3.9	4	4	0.16	0.04	0.46	4	0	0	0
Acenaphthylene	0.044	0.64	2	0.37	0.59	4	4	0.14	0.12	0.15	4	0	0	0
Anthracene	0.085	1.1	2	1.33	2.4	4	4	0.29	0.27	0.31	4	0	0	0
Benzo(a)pyrene	0.43	1.6	2	1.93	3.2	4	4	0.69	0.61	0.85	4	0	0	0
Benzo(a)anthracene	0.261	1.6	2	2.07	3.7	4	4	0.59	0.52	0.65	4	0	0	0
Benzo(ghi)perylene	0.17	–	2	1.02	1.7	4	4	0.40	0.26	0.63	4	NA	0	0
Benzo(k)fluoranthene	0.24	–	2	0.77	1.2	4	4	0.37	0.33	0.44	4	NA	0	0
Chrysene	0.384	2.8	2	2.25	3.8	4	4	0.73	0.62	0.94	4	0	0	0
Dibenz(a,h)anthracene	0.063	0.26	2	0.28	0.47	4	4	0.11	0.084	0.15	4	0	0	0
Fluoranthene	0.6	5.1	2	3.70	6.4	4	4	0.95	0.18	1.3	3	0	0	0
Fluorene	0.019	0.54	2	0.63	1.2	4	4	0.10	0.053	0.21	4	0	0	0
Indeno(1,2,3-cd)pyrene	0.2	–	2	0.98	1.6	4	4	0.42	0.3	0.64	4	NA	0	0
2-Methylnaphthalene	0.07	0.67	2	0.37	0.67	4	4	0.07	0.064	0.085	1	0	0	0
Phenanthrene	0.24	1.5	2	1.20	2.2	4	4	0.32	0.28	0.36	4	0	0	0
Pyrene	0.665	2.6	2	4.30	7.3	4	4	1.14	0.24	1.6	3	0	0	0
Total PAHs	4	45	2	25.9	44.83	4	4	7.41	4.431	9.167	4	0	0	0
Aluminum	–	18000	2	24850	25300	4	4	26800	25500	30000	NA	4	4	4
Arsenic	8.2	70	2	76.9	107	4	4	30.6	28.3	35.8	4	0	0	0
Barium	–	48	2	224	245	4	4	157	142	192	NA	4	0	0
Cadmium	1.2	9.6	2	4.10	5.9	4	4	2.40	2.2	2.6	4	0	0	0
Chromium	81	370	2	169	198	4	4	123	116	134	4	0	0	0
Cobalt	–	10	2	14.9	15.4	4	4	14.7	14	15.5	NA	4	2	1
Copper	34	270	2	500	587	4	4	274	257	302	4	2	0	0
Lead	47	218	2	307	322	4	4	209	198	230	4	1	0	0
Manganese	–	260	2	472	540	4	4	693	604	766	NA	4	4	4
Mercury	0.15	0.71	2	4.80	7	4	4	2.63	2.4	3.2	4	4	0	0
Nickel	21	52	2	62.0	64.3	4	4	48.4	46.6	52.3	4	1	0	0
Selenium	–	1	2	5.40	8	4	3	1.70	0	3.4	NA	3	0	0
Silver	1	3.7	2	5.15	7.9	4	4	4.58	4.2	5.2	4	4	1	0
Vanadium	–	57	2	69.8	80.9	4	4	70.5	67	77.4	NA	4	2	0
Zinc	150	410	2	511	617	4	4	382	376	393	4	0	0	0

The data from the samples collected from the sediment of the Arthur Kill indicate that sediment COPECs detected above the ER-L and ER-M include SVOCs (mostly PAHs) and metals. None of the SVOCs that exceeded the ER-L and/or ER-M were detected above the background average concentration. Of the metals aluminum, cobalt, managanese, silver and vanadium were greater than the background average. Of these only aluminum, manganese and cobalt are above the background maxium concentration.

4.4 Bathymetric Survey

On March 21, 2014, a bathymetric survey was completed in the lower reach of Woodbridge Creek at the confluence of the Arthur Kill. The survey was completed by Aqua Survey using boat-mounted equipment that provided sediment surface elevations relative to mean sea level. The sediment elevations established by the bathymetric survey indicate that the surface profile of the sediment in this area is generally featureless until the bottom abruptly drops over 30 feet to the bottom of the Arthur Kill. The bathymetric survey proceeded east to the edge of Staten Island in New York, and shows the width of the Arthur Kill channel as a flat bottom that rises abruptly close to Staten Island. This profile is consistent with a profile surveyed for the Arthur Kill and described in the *Subsurface Investigation and Foundation Evaluation for the Linden Cogeneration Transmission Cable*, November 1990 (Ebasco Services, Inc.). The bathymetric profile indicates that the eastern extent of the Woodbridge Creek sediments likely terminate at or near the channel scarp of the Arthur Kill where they were subject to tidal erosion force and historical dredging activities (Figure 6).

5.0 CONCLUSIONS

As part of the Supplemental EE, Chevron completed the re-evaluations of COPECs, the collection of additional sediment samples in Spa Spring Creek and Woodbridge Creek including analysis for EPH. In addition a bathymetric survey was completed in the lower Woodbridge Creek. The following conclusions are based on the Supplemental EE action discussed above:

- Spa Spring Creek, Woodbridge Creek and Arthur Kill are environmentally sensitive natural resources present adjacent to the site, and environmentally sensitive areas are not present on-site;
- Pathways for contaminant migration from SWMUs and AOCs to environmentally sensitive natural resources do not appear to be complete.
- COPECs including VOCs, SVOCs, pesticides and metals are present in sediment and surface water at concentrations above the ESC;
- Copper, nickel and zinc were detected above the SWQC in surface water sample locations at low concentrations in unfiltered samples;
- Staining and/or petroleum odors were observed in several sediment vibracores during the December 2002 sampling event. Stained soils were also observed in background and near site samples collected in 2014. These samples were analyzed/reanalyzed for EPH, and concentrations ranged from 1,640 ppm to 59,300 ppm.
- Based on the bathymetry, the Woodbridge Creek sediments terminate at the confluence of Woodbridge Creek and Arthur Kill.

As discussed in the November 2003 RFI and Section 1.2 of this report, background sources are a likely contributor to the presence of COPECs in sediment and in surface water in Woodbridge Creek and Spa Spring Creek.

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